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Pre- and postpartum supplementation strategies on the performance and metabolic status of grazing beef cows

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Abstract – The objective of this work was to evaluate the effect of energy-protein supplementation in pre- and postpartum periods on the productive and metabolic responses of grazing beef cows on tropical pasture. A group of 48 multiparous Nellore cows, with an initial gestation period of 6.4 months, body weight (BW) of 514.9 kg, and body condition score (BCS) of 5.4, was distributed in a completely randomized design, in a 2×2 factorial arrangement. The evaluated treatments were: UNS-UNS, unsupplemented during prepartum and postpartum; UNS-SUP, unsupplemented during prepartum and supplemented during postpartum; SUP-UNS, supplemented during prepartum and unsupplemented during postpartum; and SUP-SUP, supplemented during pre- and postpartum. The energy-protein supplement was offered at an amount of 1.5 kg per animal per day. Prepartum supplementation increased average daily gain and BCS at calving. Prepartum supplementation reduced non-esterified fatty acids (NEFA) and increased serum concentrations of total proteins and globulins during postpartum. Postpartum supplementation increased the BCS of cows and BW of calves at the end of the experiment. Postpartum supplementation increased blood concentrations of progesterone, while NEFA decreased. Supplementation with 1.5 kg per day of the energy-protein supplement during the last 84 days of gestation improves productive performance and metabolic status during the pre- and postpartum periods of grazing cows.

Index terms: Nellore cows, periparturient period, ruminant nutrition, tropical forage.

Estratégias de suplementação pré e pós-parto no desempenho e no estado metabólico de vacas de corte em pastejo

Resumo – O objetivo deste trabalho foi avaliar o efeito da suplementação energético-proteica no pré e pós-parto sobre as respostas produtivas e metabólicas de vacas de corte, em pastagem tropical. Um grupo de 48 vacas Nelore multíparas, com tempo de gestação inicial de 6,4 meses, peso corporal (PC) de 514,9 kg e escore de condição corporal (ECC) de 5,4, foi distribuído em delineamento inteiramente casualizado, em arranjo fatorial 2×2. Os tratamentos avaliados foram: UNS-UNS, não suplementado no pré e pós-parto; UNS-SUP, não suplementado no pré-parto e suplementado no pós-parto; SUP-UNS, suplementado no pré-parto e não suplementado no pós-parto; e SUP-SUP, suplementado durante o pré e o pós-parto. O suplemento energético-proteico foi oferecido na quantidade de 1,5 kg por animal por dia. A suplementação pré-parto aumentou o ganho médio diário e o ECC ao parto. A suplementação pré-parto reduziu os ácidos graxos não esterificados (AGNE) e aumentou as concentrações séricas de proteínas totais e globulinas durante o pós-parto. A suplementação pós-parto aumentou o ECC das vacas e o PC dos bezerros ao final do experimento. A suplementação pós-parto aumentou as concentrações sanguíneas de progesterona, enquanto os níveis de AGNE diminuíram. A suplementação com 1,5 kg por dia de suplemento energético-proteico durante os últimos 84 dias de gestação melhora o desempenho produtivo e o status metabólico durante os períodos pré e pós-parto de vacas em pastejo.

Termos para indexação: vacas Nelore, período periparto, nutrição de ruminantes, forragem tropical.

Introduction

The performance of grazing beef cows depends on forage characteristics under tropical conditions. However, forage does not represent a balanced diet as it has nutritional limitations that restrict intake and digestion and the metabolizability of absorbed substrates (Detmann et al., 2017).

According to observations of Sotelo et al. (2018), beef cows show low nutrient intake and have limited body reserves during the prepartum and postpartum periods, while fetal growth in the last trimester of pregnancy and colostrum and milk production after calving are accelerated. Consequently, nutritional requirements and the intensity of the negative energy balance of cows increase in the postpartum period (Astessiano et al., 2013). The sum of these factors promotes higher body reserve mobilization in animals. Thus, strategic supplementation programs are often required to improve the prepartum and postpartum performance of cows under tropical conditions.

Some studies have shown beneficial effects of supplementation at the prepartum (Alexander et al., 2002) or postpartum stage (Ciccioli et al., 2003) or during both periods on the productive and metabolic responses of grazing beef cows (Silva et al., 2017b; Sotelo et al., 2018; Almeida et al., 2020). However, Moura et al. (2020) observed an increase in performance without improvement of the metabolic status of animals.

The objective of this work was to evaluate the effects of energy-protein supplementation during the prepartum and/or postpartum periods on productive performance and metabolic status of beef cows grazed on tropical pasture.

Materials and Methods

The experiment was carried out in the beef cattle sector of the animal science department of the Universidade Federal de Viçosa, in municipality of Viçosa, MG, Brazil (20°45'S, 42°52'W), from July to December, during the dry season, dry-rainy transition season, and rainy season. The climate of the area was classified according to Köppen-Geiger as Cwa (humid temperate, with dry winter, hot summer) (Kottek et al., 2006). The experimental area was located in a mountainous region, with an altitude of 670 m, average temperature of 20.9ºC, and rainfall of 609.6 mm. The experiment lasted 168 days, divided into two sequential experimental periods (prepartum and postpartum), each period having 84 days.

This study used 48 multiparous Nellore cows, with an initial mean gestation time of 6.4±0.42 months, body weight (BW) of 514.9±8.9 kg, and body condition score (BCS) of 5.4±0.14 (on a scale of 1–9), managed on four 7-ha paddocks of *Uroclhoa decumbens* (Stapf) R.D. Webster [syn. *Brachiaria decumbens* Stapf] and provided with covered feeders and drinking water. All the animals had unrestricted access to water and a mineral mixture (50.00% dicalcium phosphate; 47.19% sodium chloride; 1.50% zinc sulfate; 0.70% copper sulfate; 0.05% cobalt sulfate; 0.05% potassium iodate; 0.01% sodium selenite; and 0.5% manganese sulfate).

The animals were distributed in a completely randomized 2×2 factorial design of two supplementation strategies (unsupplemented and supplemented) and two periods (prepartum and postpartum) and four treatments with 12 replications (an individual cow was considered to be the experimental unit). The treatments evaluated were: UNS-UNS – unsupplemented (only the mineral mixture was given) in the prepartum and postpartum periods; UNS-SUP – unsupplemented in the prepartum period and supplemented with 1.5 kg per animal per day of an energy-protein supplement in the postpartum period; SUP-UNS – supplemented with 1.5 kg per animal per day of the energy-protein supplement in the prepartum period and unsupplemented in the postpartum period; and SUP-SUP – supplemented with 1.5 kg per animal per day of the energy-protein supplement in both the prepartum and postpartum periods.

The supplement was formulated to contain 25% crude protein (CP) based on the natural matter (Table 1). The amount of 1.5 kg per animal per day of supplement contained 375 g of CP selected to provide approximately 40% of the CP requirements for a cow with a BW of 520 kg and an average daily weight gain of 0.5 kg per day, according to Valadares Filho et al. (2016), and was provided daily to the animals at 10:00.

A representative sample of the supplement was obtained monthly for further analysis. In addition, pasture samples were obtained every 14 days to quantify forage dry matter (DM) and potentially digestible DM (pdDM). Samples were removed from each experimental paddock by cutting the pasture close to the ground in four randomly selected areas delimited by a 0.5×0.5 m metal square. After collection, each sample was weighed and homogenized and the samples from each paddock were combined to prepare a composite sample. A second pasture sample was obtained via manual grazing simulation every 14 days for qualitative pasture assessment. Sampling was based on identification of the places cropped and the plant parts selected by the animals to simulate the cows' grazing as closely as possible. The supplement and pasture samples were identified, weighed, and oven-dried in a forced-air circulation oven (ArSL – 102; Solab, Piracicaba, São Paulo, Brazil) immediately after collection at 60ºC for 72 h. The samples were then ground with a Wiley mill fitted with 2- and 1-mm mesh screens (TE-680, Solab) and stored in plastic pots before analysis.

The animals were weighed without fasting and their BCS was evaluated at the beginning of the experiment (84 days before the expected calving date), 7 days before the expected date of parturition, at calving, and at the end of the experiment (84 days after calving). The calves were weighed at birth and at 84 days postpartum. The cows were weighed at 06:00, except on the day of calving. The BCS was assessed by four trained raters using a scale of 1–9 as recommended by the NRC (1996), and BW was corrected to shrunk BW, according to Gionbelli et al. (2015), in order to avoid the possible confounding effect of the last meal filling the digestive tract: $SBW = 0.8084 \times BW^{1.0303}$, where SBW was the shrunk body weight (kg) and BW was the body weight (kg).

To estimate milk production and composition, milk samples were obtained at 45 days postpartum of experiment following procedures described by Almeida et al. (2018).

At the end of the prepartum and postpartum periods, corresponding to 7 days before the expected parturition date and 7 days before the end of the experiment, respectively, subcutaneous fat thickness (SFT) and loin muscle area (LMA) were measured on the longissimus dorsi muscle, between the 12th and 13th ribs (SFT*l* and LMA), and on the P8 site (SFT*r*) using ultrasonography to assess the energy status (adipose tissue deposition) of the animals.

Blood samples were collected 30, 15, and 7 days prior to parturition, on calving day, and 7, 15, 30, and 60 days after parturition to quantify the concentration of urea, total proteins, albumin, globulins, glucose,

Table 1. Ingredients and chemical composition of the supplement and forage consumed by beef cows during the experimental period.

Item(1)	Supplement	Prepartum forage(2,4)	Postpartum forage(3,4)
Ingredient % (as fed basis)			
Corn meal	50.00	-	-
Wheat bran	27.00	-	-
Soybean meal	20.00	-	-
Urea: ammonium sulfate (9:1)	3.00	-	-
Chemical composition (g kg^{-1} DM)			
Dry matter	883.60	812.9±0.15	896.1±1.82
Organic matter	968.30	928.2±0.54	919.1±1.00
Crude protein	249.80	89.2±0.43	89.6±0.64
Ether extract	29.30	20.4±0.06	17.2±0.07
Non fibrous carbohydrates	497.30	150.3±0.51	123.2±0.82
NDFap	191.90	668.3±5.02	689.1±5.78
iNDF	56.10	156.4±0.32	153.8±0.28

(1)NDFap, neutral detergent insoluble fiber corrected for ash and protein; and iNDF, indigestible neutral detergent insoluble fiber. (2)Samples obtained from a grazing simulation in the prepartum. (3)Samples obtained from a grazing simulation in the postpartum. (4)Means ± standard error of the mean.

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NEFA, and β-hydroxybutyrate (BHB). In addition, blood was collected on day 60 postpartum to measure the serum progesterone concentration. Blood samples were collected at 07:00 via jugular vein puncture using vacuum tubes with gel for serum separation and clot activator and vacuum tubes with sodium fluoride and EDTA as glycolytic inhibitor and anticoagulant for glucose analysis. The blood was immediately centrifuged at 3,600 g for 20 minutes, and the serum and plasma were stored at -20ºC.

Forage and supplement samples (ground through 1-mm sieves) were analyzed according to the procedures described by Detmann et al. (2012) for DM, ash, crude protein (CP), ether extract, and neutral detergent fiber corrected for ash and protein (NDFap). The indigestible NDF (iNDF) content in feces, forage, and supplement samples (ground through 2-mm sieves) were estimated according to Detmann et al. (2012).

Potentially digestible DM (pdDM) was estimated according to the following equation described by Paulino et al. (2008): pdDM = 0.98 × (100 – NDF) + (NDF – iNDF).

The quantification of non-fibrous carbohydrates (NFC) was performed according to Detmann & Valadares Filho (2010): NFC = 100 − [(%CP − %CP urea + % urea) + %NDFap + %EE + %MM], where NDFap was neutral detergent fiber corrected for ash and protein.

Milk protein, fat, lactose, and total solids concentrations were quantified using an infrared spectrophotometer (Foss MilkoScan FT120, Hillerød, Denmark). Blood glucose concentration was quantified with the enzymatic colorimetric method (K082, Bioclin Quibasa, Belo Horizonte, Brazil). Urea in serum (K056–1, Bioclin Quibasa, Belo Horizonte, Brazil) was quantified with the enzymatic kinetic method, albumin (K040–1, Bioclin Quibasa, Belo Horizonte, Brazil) and total protein (K031–1, Bioclin Quibasa, Belo Horizonte, Brazil) with the colorimetric method, NEFA (FA115, Randox Laboratories Ltd., Antrim, UK) with the colorimetric method, and BHB (B1007, Randox Laboratories Ltd., Antrim, UK) with the enzymatic method. Serum urea N (SUN) was estimated as 46.67% of total serum urea. Globulin concentrations were calculated as the difference between total protein and albumin. An automatic biochemistry analyzer (Mindray BS200E, Shenzhen, China) was used for all analyses. Progesterone concentrations were quantified with indirect chemiluminescence, using Access Progesterone Reagent (33550, Beckman Coulter, Brea, USA) in the Access 2, and Immunoassay System (Beckman Coulter Inc., Brea, USA).

The experiment had a completely randomized design. The MIXED procedure of SAS 9.4 (Statistical Analysis System, Inc., Cary, NC, USA) was used for all statistical analyses. The data were analyzed using ANOVA tests adopting the initial BW as the covariate. Analyses of variance of the variables studied were performed according to the following mathematical model: $Y_{ij} = \mu + T_i + \varepsilon_{ij}$, where Y_{ij} was the dependent variable corresponding to individual j undergoing treatment i; μ was the general mean; T_i was the fixed effect of the treatment; ε_{ij} was unobservable random error associated with each observation j submitted to treatment i under the assumption of normal and independent distribution (0, σe^2).

To determine the effect of the variables measured during the prepartum period, the treatments (two treatments) were evaluated as a simple comparison between cows that received the supplement and cows that did not receive supplement. To determine the effects of the variables measured during postpartum, the sums of squares of treatments (four treatments) were decomposed using orthogonal contrasts to test the interaction and independent effects of supplementation in a 2×2 factorial design. Blood concentrations were analyzed as repeated measures, and collection day was considered the repeated variable. The best (co)variance structure was chosen based on the Akaike's information criterion with correction. The degrees of freedom were estimated according to the Kenward-Roger method. Differences were considered significant at $p \leq 0.05$, and trends were identified when $0.05 < p \leq 0.10$.

Results and discussion

The overall mean of pdDM available during the prepartum and postpartum periods was 3.44 (75.35 g kg^{-1} BW) and 3.15 (76.62 g kg^{-1} BW) t ha^{-1}, respectively. The average CP content of the pasture consumed by the animals during pre- and postpartum periods was 89.6 g CP kg^{-1} DM, and that of the supplement offered to the animals that received supplement was 249.8 g CP kg^{-1} DM (Table 1).

The overall mean pdDM mass (75.99 g pdDM kg^{-1} BW) in the prepartum and postpartum periods was

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above that recommended by Paulino et al. (2008), who suggested forage provision of 40–50 g pdDM kg^{-1} BW for satisfactory performance of grazing cattle. So, the forage mass was not a limiting factor for voluntary intake and performance of animals.

The percentage of CP in forage in the prepartum and postpartum periods was above the critical limit (80 g CP kg^{-1} DM) necessary for adequate use of fiber (Lazzarini et al., 2009). However, these values were lower than the optimal level (100 g CP kg^{-1} DM) for the use of energy substrates in forage – this justifies the supplementation with nitrogen compounds in the prepartum and postpartum periods in order to optimize the use of forage and, consequently, animal performance (Sampaio et al., 2009).

In the prepartum period, supplementation increased BW and average daily gain (ADG) of cows. In addition, cows that received supplement in the prepartum period had higher BW and BCS at calving. However, there was no effect of prepartum supplementation on BCS, LMA, SFT*l*, and SFT*r* of cows and calf body weight at birth (Table 2).

In the postpartum period, the interaction between the treatments applied in the prepartum and postpartum periods had a significant effect on calves' BW at the end of the experiment (Table 2). Closer examination

Table 2. Productive performance of beef cows grazed on tropical pasture and subject to strategic supplementation in both prepartum and postpartum periods.

Parameter[(1)]	Treatments[(2)]				SEM[(3)]	p-value[(4)]			
	Unsupplemented		Supplemented			PRE	Overall		
							PRE	POS	PRE×POS
84 d prepartum									
Body weight (kg)	514.5		521.2		13.08	0.717	-	-	-
Body condition score	5.6		5.2		0.16	0.262	-	-	-
7 d prepartum									
Body weight (kg)	501.7		535.6		11.69	0.046	-	-	-
Average daily gain (kg per day)	-0.167		0.186		0.0452	<0.001	-	-	-
Body condition score	5.4		5.6		0.11	0.337	-	-	-
LMA (cm^2)	46.5		48.6		1.39	0.388	-	-	-
SFT*l* (mm)	4.9		3.9		0.60	0.335	-	-	-
SFT*r* (mm)	6.6		5.4		0.72	0.380	-	-	-
Calving									
Body weight (kg)	473.4		513.3		11.65	0.019	-	-	-
Body condition score	5.2		5.7		0.14	0.009	-	-	-
Calf body weight (kg)	33.8		35.3		1.00	0.318	-	-	-
84 d postpartum	UNS	SUP	UNS	SUP					
Body weight (kg)	463.3	487.4	500.4	509.2	16.43	-	0.086	0.332	0.650
Average daily gain (kg per day)	-0.057	0.099	-0.130	-0.065	0.0720	-	0.114	0.139	0.543
Body condition score	4.4	5.2	5.5	5.7	0.19	-	<0.001	0.025	0.153
LMA (cm^2)	45.6	48.5	51.2	50.0	1.85	-	0.064	0.643	0.286
SFT*l* (mm)	4.2	4.5	4.0	4.1	0.66	-	0.683	0.701	0.911
SFT*r* (mm)	5.5	6.1	6.1	6.2	0.79	-	0.677	0.679	0.699
Calf body weight (kg)	90.9	89.1	78.7	100.6	4.15	-	0.935	0.023	0.008

[(1)]LMA, longissimus muscle area; SFT*l*, subcutaneous fat thickness at the loin; SFT*r*, subcutaneous fat thickness at the rump. [(2)]UNS-UNS, unsupplemented during prepartum and postpartum periods; UNS-SUP, unsupplemented during prepartum and supplemented with 1.5 kg per day of an energy-protein supplement in the postpartum; SUP-UNS, supplemented with 1.5 kg per day of an energy-protein supplement in the prepartum and unsupplemented during postpartum; SUP-SUP, supplemented with 1.5 kg per day of an energy-protein supplement during prepartum and postpartum periods. [(3)]SEM, standard error of the mean. [(4)]PRE, supplementation effect in the prepartum; POS, supplementation effect in the postpartum; PRE × POS, interaction between prepartum and postpartum treatments.

of this effect indicated that the BW of the calves only increased when the cows received supplementation during both prepartum and postpartum periods. Supplementation in the prepartum period influenced the productive performance of the animals in the postpartum period. Thus, cows that received supplementation in the prepartum period had a higher BCS, and an increasing trend was noted for BW and LMA in the postpartum period. In contrast, prepartum supplementation did not affect ADG, SFT*l*, and SFT*r* of cows and BW of calves at the end of the experiment (Table 2). However, postpartum supplementation was not sufficient to increase the BW, ADG, LMA, SFT*l*, and SFT*r* of cows.

The better animal performance in the prepartum and postpartum periods was probably associated with the higher intake of CP and metabolizable energy (EM) provided by the supplement in the prepartum period, since cows that received supplementation in this period had higher CP throughout the experiment. This has possibly lead to an adequate energy:protein ratio in the diet and greater use of forage energy (Silva et al., 2017b; Sotelo et al., 2018; Almeida et al., 2020).

On the other hand, the higher supply of nutrients during late gestation was not sufficient to improve fetal development since the BW of calves at birth was similar between treatments (Table 2). Several authors have reported an association between increased performance of beef cows in the prepartum period and fetal development. However, in the postpartum period, they did not observe an increased productive response in beef cows that received supplement under tropical conditions (Silva et al., 2017b; Sotelo et al., 2018; Almeida et al., 2020; Moura et al., 2020).

Supplementation did not promote enough changes to favor fat deposition in the prepartum period, which would explain the similar BCS, SFT*l,* and SFT*r* observed in prepartum animals (Silva et al., 2017a; Almeida et al., 2020; Moura et al., 2020). However, the increase in BCS of cows that received supplement, from calving to the end of the experimental period, indicates an increase in adipose tissue deposition. In this study, in contrast to animals that did not receive supplement, cows receiving supplement during the pre- and/or postpartum period had a BCS of 5.7 from calving, a value higher than that recommended by Lents et al. (2000), suggesting a potential increase in the reproductive response consistent with the increase in serum concentrations of progesterone.

Supplementation in the prepartum and/or postpartum periods did not affect milk yield (average 7.86 kg per day) or the concentration of lactose (average 4.46 g kg^{-1}), protein (average 3.03 g kg^{-1}), fat (average 4.98 g kg^{-1}), and total solids (average 13.62 g kg^{-1}) in milk. According to Baumgard et al. (2017), this answer suggests the dominance of the homeorhetic mechanisms responsible for favoring milk biosynthesis, demanding a high input of energetic nutrients, which can be verified in the body and metabolic changes in the cows at postpartum in our study.

In the prepartum period, the interaction between treatment and collection day had a significant effect on blood concentrations of SUN and NEFA (Table 3). Cows that received supplement had higher SUN and lower NEFA levels at 15 and 7 days before the parturition date compared to cows that did not receive supplement (Figure 1a and 1b). Nevertheless, there was no effect of the interaction between treatments and collection day on serum concentrations of total proteins, albumin, globulins, glucose, and BHB. In addition, a downward trend in BHB levels was observed in cows that received supplement, compared to cows that did not receive supplement.

In the prepartum period, collection day (30, 15, or 7 days before parturition) had significant effects on blood concentrations of the measured metabolites (Table 3). Thus, the concentrations of total proteins and globulins decreased from the first collection 30 days before parturition, with the lowest values at calving day. Glucose concentration in blood was lowest on day 7 before calving. In contrast, BHB concentration was highest on day 7 prior to parturition.

In the postpartum period, the interaction between treatment and collection day (7, 15, 30, and 60 days after parturition) had a significant effect on blood concentrations of SUN, total proteins, globulins, glucose, and BHB, while NEFA levels showed a decreasing trend. Further investigation of this effect showed that SUN concentrations were only higher in cows that received supplement during the postpartum period (Figure 2 A). Serum concentrations of total proteins and globulin were higher throughout the postpartum period in cows that received supplement in the prepartum period (Figure 2 B and D). Serum concentrations of NEFA were higher up to 15 days in cows that received supplementation in the postpartum period, with an increase observed in all treatments at 60 days after parturition (Figure 2 E). On the other hand, blood concentrations of BHB were higher from day 15 after parturition in cows that received supplementation in the prepartum and/or postpartum periods (Figure 2 C). Finally, serum glucose concentrations were lowest at day 7 after parturition in cows that received prepartum supplementation (Figur 2 F).

The higher concentrations of SUN, total proteins, albumin, and globulin may be attributed to higher CP intake through supplementation since the blood concentrations of these metabolites are related to the availability of amino acids and nutrients (Lawrence, 2012). These results are consistent with those reported by Silva et al. (2017a) and Sotelo et al. (2018), which indicates the higher protein status of cows receiving the energy-protein supplement in the prepartum and/or postpartum period. The globulin concentrations observed during the postpartum period suggest changes in humoral immunity and, consequently, an increase in the serum levels of this metabolite (Titgemeyer & Löest, 2001).

The levels of blood glucose observed in the prepartum period indicate a similar energy status between cows that received supplement and cows that did not receive supplement (Table 3), in agreement with the observations by Sotelo et al. (2018).

Prepartum supplementation did not have an effect on postpartum serum progesterone concentrations. However, there was a significant increase in blood progesterone concentrations in cows that received supplement during the postpartum period (Table 3). In the prepartum and postpartum periods, collection day had a significant effect on blood albumin concentration.

The better energy status of the cows that received supplement possibly led to an increase in progesterone synthesis, suggesting higher luteal activity (Martin et al., 2010), which is related to the responses of energy status indicators evaluated in this study.

Table 3. Metabolic profile of beef cows grazed on tropical pasture and receiving strategic supplementation in the prepartum and postpartum periods.

Parameter[1]	Treatments[2]				SEM[3]	p-value[4]							
	UNS		SUP			PRE			Overall				
					±	T	D	T×D	PRE	POS	PRE×POS	D	T×D
Prepartum													
SUN (mg dL^{-1})	11.8		15.3		1.02	0.132	<0.001	0.001	–	–	–	–	–
Total proteins (g dL^{-1})	7.07		7.09		0.117	0.885	0.001	0.521	–	–	–	–	–
Albumin (g dL^{-1})	3.33		3.28		0.035	0.252	0.010	0.645	–	–	–	–	–
Globulins (g dL^{-1})	3.73		3.81		0.126	0.647	<0.001	0.487	–	–	–	–	–
Glucose (mg dL^{-1})	63.9		62.6		1.20	0.536	<0.001	0.293	–	–	–	–	–
NEFA (mmol L^{-1})	0.61		0.38		0.041	0.039	<0.001	<0.001	–	–	–	–	–
BHB (mmol L^{-1})	0.63		0.51		0.034	0.082	<0.001	0.415	–	–	–	–	–
Postpartum	UNS	SUP	UNS	SUP									
SUN (mg dL^{-1})	9.6	12.2	10.4	12.7	0.54	–	–	–	0.225	<0.001	0.808	0.041	<0.001
Total proteins (g dL^{-1})	7.09	7.04	7.57	7.40	0.162	–	–	–	0.018	0.513	0.702	<0.001	0.012
Albumin (g dL^{-1})	3.25	3.26	3.29	3.35	0.026	–	–	–	0.027	0.214	0.486	0.013	0.553
Globulins (g dL^{-1})	3.84	3.78	4.28	4.05	0.165	–	–	–	0.050	0.410	0.626	0.005	0.035
Glucose (mg dL^{-1})	66.2	64.6	64.0	61.7	1.21	–	–	–	0.042	0.113	0.747	<0.001	0.006
NEFA (mmol L^{-1})	0.42	0.33	0.41	0.37	0.028	–	–	–	0.605	0.030	0.473	<0.001	0.096
BHB (mmol L^{-1})	0.49	0.49	0.51	0.45	0.022	–	–	–	0.561	0.769	0.019	0.001	0.008
Progesterone (ng mL^{-1})	1.50	5.51	2.47	5.63	1.434	–	–	–	0.705	0.018	0.768	–	–

[1]SUN, serum urea nitrogen; NEFA, non-esterified fatty acids; and BHB, β-hydroxybutyrate. [2]UNS-UNS, unsupplemented during prepartum and postpartum periods; UNS-SUP, unsupplemented during prepartum and supplemented with 1.5 kg per day of an energy-protein supplement in the postpartum; SUP-UNS, supplemented with 1.5 kg per day of an energy-protein supplement in the prepartum and unsupplemented during postpartum; and SUP-SUP, supplemented with 1.5 kg per day of an energy-protein supplement during prepartum and postpartum periods. [3]SEM, standard error of the mean. [4]PRE, prepartum; overall, prepartum and postpartum; T, applied treatment effect; D, collection day effect; T × D, interaction between treatment and collection day; PRE, supplementation effect in the prepartum; POS, supplementation effect in the postpartum; PRE × POS, interaction between prepartum and postpartum treatments.

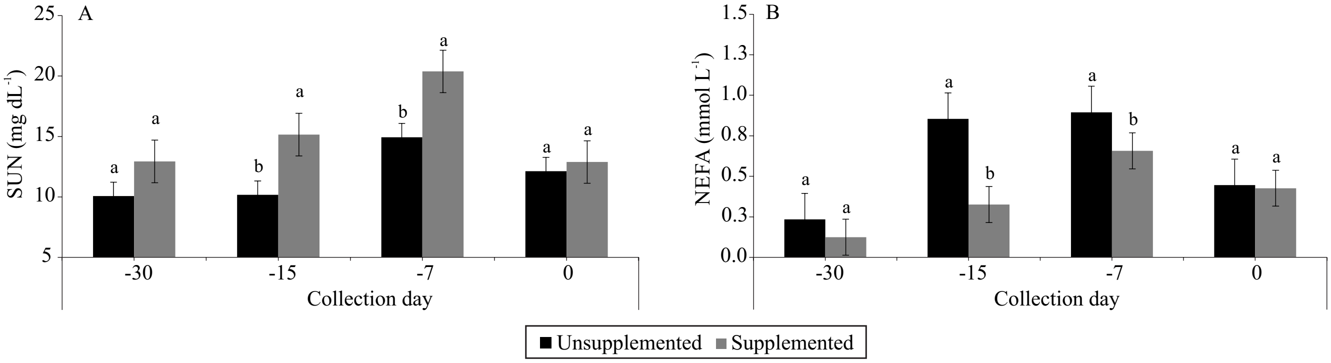

Figure 1. Prepartum blood concentrations of serum urea nitrogen (SUN) and non-esterified fatty acids (NEFA) of grazing beef cows on tropical pasture receiving an energy-protein supplement during the prepartum period. Treatments: unsupplemented; and supplemented during prepartum with 1.5 kg per day of an energy-protein supplement. Treatment mean × day: same combinations with different lowercase letters differ significantly by F test at 5% probability.

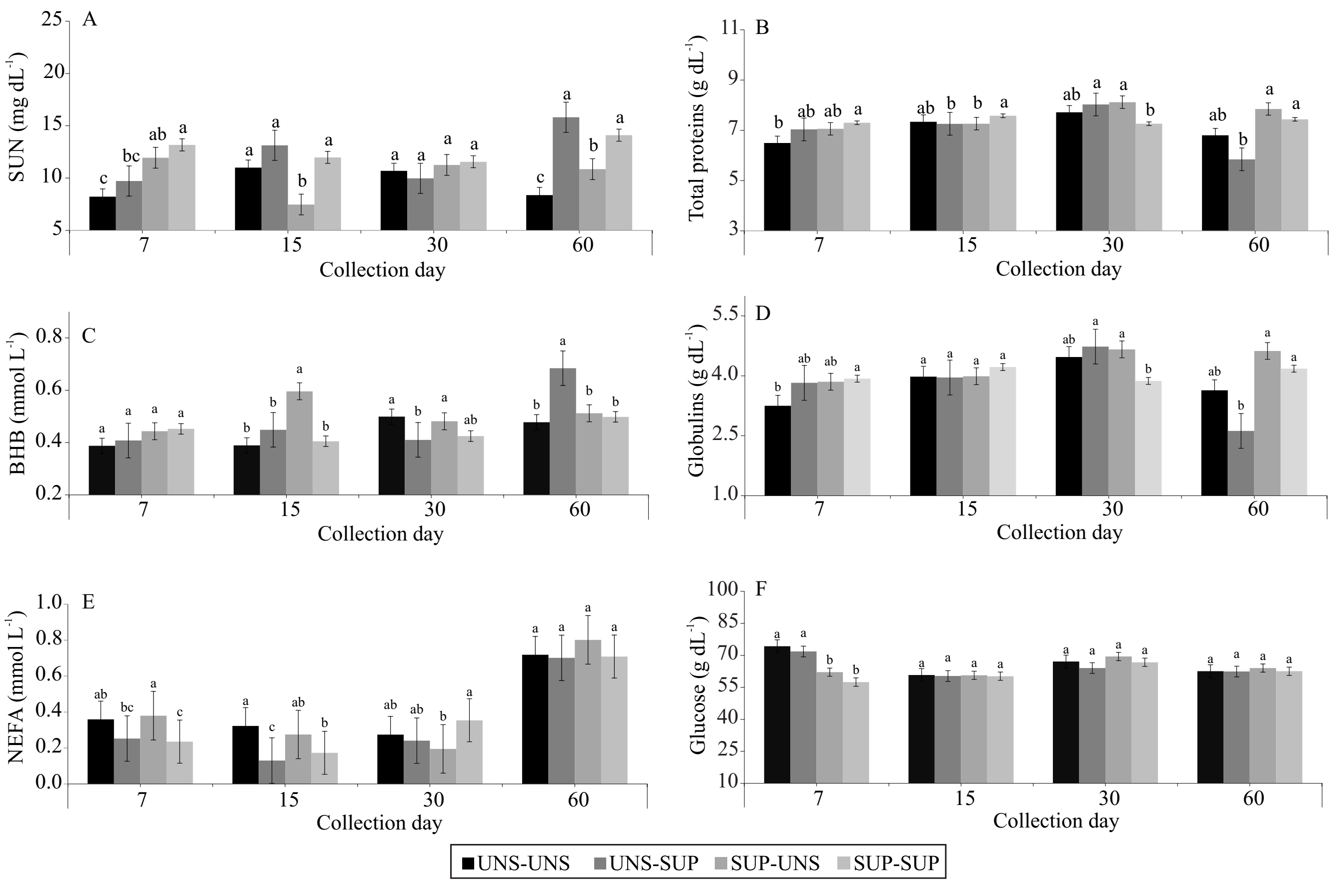

Figure 2. Postpartum blood concentrations of serum urea nitrogen (SUN), total proteins, β-hydroxybutyrate (BHB), globulins, non-esterified fatty acids (NEFA), and glucose of grazing beef cows on tropical pasture receiving supplementation in the prepartum and postpartum periods. Treatments: UNS-UNS, unsupplemented during prepartum and postpartum periods; UNS-SUP, unsupplemented during prepartum and supplemented with 1.5 kg per day of an energy-protein supplement during the postpartum; SUP-UNS, supplemented with 1.5 kg per day of an energy-protein supplement in the prepartum and unsupplemented during postpartum; SUP-SUP, supplemented with 1.5 kg per day of an energy-protein supplement during prepartum and postpartum. Means of treatment × day: same combinations followed by different letters differ significantly by orthogonal contrast test at 5% probability.

Conclusions

The supply of 1.5 kg per day of an energy-protein supplement during the last 84 days of gestation improves the productive performance and metabolic status during the prepartum and postpartum periods of beef cows managed on tropical pasture.

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